Global Warming, Vulnerability and Policy Implications for Malaysia

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Abstract

The Intergovernmental Panel for Climate Change (IPCC) report on the "Science of Climate Change" in 2007 states that the Southeast Asia Region experienced a small increase in temperature (~ 0.3 ^{o}C) and rainfall (~ 3%) for the last decade or so, however, there is general agreement amongst scientists that the changing behavioural patterns of the el-Nino ENSO , Monsoons and to a certain extent the Indian Dipole Oscillation circulation systems are triggering weather extremes and variability to influence changing behavioural patterns of hydro-meteorological and geomorphological events within the major river basins (for example, floods, droughts, haze pollution, slope failures and the emergence of certain diseases) in the country. In addition to these events, Malaysia are already exposed to increasing threats (directly or indirectly) from Low Pressure Oceanic Cells (LPOC's) that develops in the South Indian Ocean (tropical storms and cyclones) and the Pacific – South China Sea Regions (tropical storms and typhoons). These events life cycles are thought to be governed by the increasing warming of ocean surface waters as a result of the global warming – climate change effect. Changing hydro-meteorological and geomorphological processes have increased in intensity, frequency and impacts to make Malaysia more aware and vigilant to the potential threat of global warming-climate change and the need for effective solutions. To this date the impact of these changes can still be absorbed by the strong foundations of Malaysia's environmental management programmes and backed by stringent economic policies including effective poverty eradication and food production programs. However, it must be understood here that the environmental policies addresses only the environmental change threat and not specifically the climate change threat where in the long term the impact scenario would generally diverge, and the resilience of Malaysia to the climate change threat would generally decrease and her vulnerability increases. This scenario can change if the gradual increase in global warming is left unchecked and unabated because increasing global temperatures could lead to thresholds been breached where habitats and ecosystems could not recover to existing equilibrium and stable conditions. Climate change could well trigger national and international distributional conflicts and intensify problems already hard to manage in the region (inter and intra regional conflicts). Malaysia could be affected in future conflict scenarios as a result of climate change. Four conflict constellations can be identified in which critical developments can be anticipated as a result of climate change impact on Malaysia. These are, conflict constellations on (1) climate-induced degradation of marine and freshwater resources, (2) climate-induced decline in food production capacities and other environmentally driven economic systems, (3) climate-induced increase in certain hydro-meteorological and geomorphological events and (4) climate change ethical – justice issues such as environmentally induced displacements and migration and the deprivation and sustenance of certain livelihood activities. The social impacts of climate change will vary in the different parts of Malaysia. "Security risks associated with climate change", shows selected hotspots can be identified. The existence of these climate change conflict constellations threaten to overstretch the established national- regional - global governance system, thus jeopardizing international stability and regional security. The last half decade had witnessed a

number of threatening environmental events that are climate change induced. These events will steadily intensify and exacerbates existing environmental risks and have serious repercussions on Malaysia. Climate extremes, variability and anomalies will threaten the bases of many of the country's populace livelihoods and her major economic systems, especially vulnerable are the poor and those living at the threshold of the poverty line. The low income economic systems are especially vulnerable as their practices are dictated and sustained by climate – weather behavioral patterns. Any changes to these behavioral patterns would seriously affects the daily practices and livelihoods of highland farmers, traditional fishing and agriculture practices of coastal regions, and other forms of rural cottage industries. Malaysia's large scale economic systems such as agriculture, fishing, hydro-electric power generation and tourism related activities are also vulnerable to climate variabilities and extremes as these industries to a major extent are environmentally driven. Climate change will hit Malaysia hard. Timely adaptation measures should therefore be an integral element of her national policies. However, like most developing countries, Malaysia lacks the skills and capacities to implement effective adaptation measures at all levels of systems been threatened. Moreover, the impacts of climate change will increase the vulnerability of weak and the more fragile systems and further reduce their adaptive capacities. The nature of vulnerability and resilience of these systems to the climate change threat needs to be assessed and understood. There's not much that Malaysia can do in mitigating and curtailing green house gases emission, where her role lies mainly to provide a powerful voice in support of global efforts in green house gases reduction and mitigation, however there's much that can be done in order to reduce vulnerability and resilience of her populace and livelihood systems. In general it can be said that the greater the warming, the greater the security risks to be anticipated, and Malaysia needs to adapt to these impending risks. The objectives of this paper is to discuss, (1) the importance and significance of global warming and climate change as emerging security issues (2) the application of a theoretical framework for climate insecurity – vulnerability study, to examine (3) the potential stresses of global warming – climate change on regional environmental systems dynamics and potential security risks hotspots, (4), the potential "critical" systems that would be seriously affected and why these systems are vulnerable, (5)) the adaptation, mitigation and future policy implications of Malaysia to address the climate change threat.

Introduction

The last decade had witnessed a number of events that have imposed greater threat and security risks on the global population especially in the developing regions of the world. These events create severe impacts on human security issues that include food, health and their livelihood activities. These threats are attributed either directly or indirectly from global warming- climate change induced hazards, poverty and more recently on the issues of escalating energy costs, diminishing supply and the sustenance of global food production, global financial crisis and more recently the H1N1A influenza pandemic. What is even more depressing about these threats are the presence of multi-cause and effect linkages between the global warming- climate change induced events as seen through the effects of non-sustainable environmental resources development, fossil fuel energy generation, breaching of environmental thresholds which could lead to habitat destruction (for example destruction of corals) or in some cases new intrusion of environmental species into a region, such as the sudden emergence of vector – borne diseases in areas previously not affected such as malaria and dengue), the sustenance of human economic activities (subsistence, traditional as well as modern economic systems) and the emerging breakdown of poverty threshold values, leading to forced migrations and the development of environmental refugees settlement. Evidences have shown that climate change could have a profound effect on the onset, timing, duration, frequency and magnitude of hydro-meteorological events (such as that associated with the behavioral patterns of rainfall events within a particular locality/region; World Meteorological Organization, 2007). Changing hydro-meteorological behavioral patterns could influence, for example, the traditional rural economic practices of the highland and coastal – island regions of developing countries. Rural economies such as agriculture, fishing, the harvesting of forest products and rural cottage industries could be severely affected by changes in the behavioral patterns of local / regional climate and weather. In urban regions, certain informal economic sectors commonly associated with the urban poor and lower income groups could also be affected when the supply of raw resources used in such simple economic systems are been affected by floods and other forms of changing urban climate and emerging weather anomalies. These relationships between changing behavioural patterns of climate and weather and their impact on the sustenance of economic practices would be become more strenuous in the future. It can be argued that climate would become a security issue when human welfare are been threatened, for some nation-states, communities and individuals that can lead to population stresses, conflicts and war. Environmental degradation, conflict and war has been dealt with by many authors before this, in fact Thomas Malthus (1776-1834) and Karl Marx (1818-1883) had postulated clearly the relationships between increasing population growth, population demand, resource depletion and degradation, population starvation and misery, large scale migrations, conflict and war. Thomas Homer Dixon (1991) a major pioneer in environmental degradation and conflict studies through a series of articles written in the 1990s and early 2000 describes the emerging issues of social decay and conflict as a result of environmental degradation. The United Nations Resolution on "Sustainable Development" of the Environment (Rio, 1992) states that the last decade or so *Man-*

Environment relationships have given rise to increasing frequencies, intensities and magnitudes of environmental hazards and disasters and the depletion of natural resources. These hazards and disasters are threatening the life of Man (Wellbeing – Health and Comfort and his livelihood Activities). This has led to United Nations Resolution on "Sustainable Development" of the Environment (Rio, 1992) – Development for Future Generations. Environmental Security thus describes the inherent carrying capacity of the environment to sustain quality and quantity so as continuously support ecological systems and human value systems. Environmental degradation would bring about environmental insecurity. Sir John Theodore Houghton (2003) as co-chair of the Intergovernmental Panel on Climate Change's (IPCC) working group describes the impacts of global warming as a "weapon of mass destruction", which like terrorism, this weapon knows no boundaries. It can strike anywhere, in any form - a heat wave in one place, a drought or a flood or a storm surge in another. Nor is this just a problem for the future, it has occurred and will intensify and creates irreparable damage to ecosystems and compromise human wellbeing. The 1990s were probably the warmest decade in the last 1,000 years, where 8 of the warmest years occurred in the last decade and 1998 the warmest year. Global warming is already upon us. However environmental insecurity could also be attributed to natural events life cycles, these could be referred to traditional environmental insecurity issues. The Millennium Project Report of 2005 also describe the emerging importance of environmental security – insecurity issues where it was stated in the report that "the condition of environmental security is one in which social systems interact with ecological systems in sustainable ways, all individuals have fair and reasonable access to environmental goods, and mechanisms exist to address environmental crises and conflicts". Sir Nicholas Stern, Head of the UK Government Economic Service, and a former Chief Economist of the World Bank in 2006 discussed in a 700 page report called the Stern Review on the Economics of Climate Change as a result global warming on the world economy. Although not the first economic report on global warming, it is significant as the largest and most widely known and discussed report of its kind. Its main conclusions are that one percent of global gross domestic product (GDP) *per annum* is required to be invested in order to avoid the worst effects of climate change, and that failure to do so could risk global GDP being up to twenty percent lower than it otherwise might be. Stern's report suggests that climate change threatens to be the greatest and widest-ranging market failure ever seen, and it provides prescriptions including environmental taxes to minimize the economic and social disruptions. *Climate Change 2007*, the Fourth Assessment Report (AR4) of the United Nations Intergovernmental Panel on Climate Change (IPCC), observes many changes in the Earth's climate including atmospheric composition, global average temperatures, ocean conditions, and other climate changes that attributed to human activities. This report states that global warming and climate change would lead to threshold breaches in sensitive systems which could not revert to their original states. In the United States the serious threat of green house gases emissions was considered a security threat and gave rise to the Lieberman-Warner Climate Security Act of 2008 — the first climate change bill to be debated in Congress. This bill was however rejected by congress on the grounds that it would not benefit the American citizen. The impact of global warming and climate change has already had its impact on physical systems dynamics and human security issues. The failure of the Kyoto

Protocol to reduce green house gases emissions may have serious repercussions to coastal and island regions susceptible to sea level rise which could lead to the displacement people there. In addition to this there is the follow- up problem of internal and international refugees that would affect the stability of social systems and structures of the receiving regions and countries. Large migrations could be the consequence of climate change. In the first instance it will be climatic extremes and increasing climate variability that will enhance migration as soils are degraded, economic systems fails, food production fails, water supplies contaminated and depleted, housing, livestock and infrastructure damaged, insurance costs rise, and human comfort, health and livelihood activities are compromised. Communities generally adapt and are generally resilient to extreme events. However, as climate becomes increasingly variable extreme events may become more frequent and more severe, and this may stretch the limits of adaptability and resilience, especially amongst the poor and lower income populations whose livelihood activities centers around traditional economic systems making migration an attractive, if not the only option. Sea-level rise for example, is very likely to induce large scale migration in the longer-term. According to scientists by 2080 the flood risk for people living on islands will be 200 times greater than in a situation where there was no global warming. Therefore, to avoid climate-induced migration and the subsequently enhanced risk of violent conflict, slowing the rate and ultimately reducing the amount of greenhouse gas emissions, as well as enhancing adaptive capacity to extreme weather events is essential. It is likely that for social-ecological systems that are highly sensitive to climate change existing avenues of migration will be explored first. In developing countries planning for enhanced internal migration and international immigration is required given that they are more vulnerable to the impacts of climate change and most existing migration is within and between developing countries. For example, many of the 5.5 million people living on the Ganges Delta in Bangladesh who will be forced to relocate with a 45cm rise in sea-level may seek to move inland within Bangladesh, but a significant number may seek to move to neighboring India and Pakistan – and previous migration of this kind has been a factor in violence and conflict in the region. Existing patterns of 'environmental refugees' may also be indicative of the places from where climate migrants might emerge as these represent movements from areas already under environmental stress, and possibly under increasing stress due to climate change. The IPCC 2007 report suggests that the most sensitive natural systems to climate change are: coral reefs, mangroves, boreal and tropical forests, polar and alpine ecosystems, prairie wetlands, and remnant native grasslands. Climate change may affect scarcities of renewable environmental resources in these regions, which in most cases are the homes of traditional economic systems associated with the poor and the lower income groups. Human systems that are most sensitive to climate change include: water supply systems, forestry activities, agricultural systems, and coastal zones and fisheries .In terms of broad geographical regions and on the basis of the central scenarios from the range of all emissions scenarios, the IPCC sees Africa as being highly vulnerable to climate change, particularly due to decreased water availability, enhanced food insecurity, impacts on human health, and increased desertification. Asia is likely to have problems with food security and flooding, but overall is probably less vulnerable than Africa (although at the upper end of the range of emissions scenarios food security would be very substantially impacted by changes in the South Asian

monsoon). Latin America is also less vulnerable than Africa, but is nevertheless likely to experience increasingly severe and possibly increasingly frequent climatic variations largely due to changes in the El Niño Southern Oscillation (ENSO), as well as decreasing biodiversity and reduced crop yields. Of all developing regions, however, it is the small island states and countries with long extensive coastlines that are most vulnerable to climate change through sea surface warming and coral bleaching, droughts and flooding, and changes in ENSO. Climate change may thus force drastic changes to livelihood strategies. Where economic diversification is low, income opportunities and hence options for developing alternative livelihoods in response to climatic changes may be limited. In some cases migration, which is an important coping strategy for poor people, might be their only solution, but will potentially cause social disruption. Climate change not only affects the poor and those living under poverty driven conditions. Climate change is expected to have effects on the overall economy of poor countries, thus hampering potential for economic growth. In addition, poor adaptation will increase the impacts of extreme events, increasing the costs of rehabilitation and diverting funds from longer term development purposes. Current extreme weather events are already taking their toll on developing countries' economies, leading to loss of human and economic capital. Regions where climate change exacerbates climatic extremes and which have limited adaptive capacity will be further constrained in their development prospects due to additional loss of life, private assets, reduced productivity of important economic sectors, and destruction of infrastructure. This is particularly true for small countries and countries with low economic diversity, where the impact of climatic extremes cannot be well absorbed by economic activity in other regions or sectors. Climate change provides an additional threat that adds to, interacts with, and can reinforce existing risks, placing additional strains on the livelihoods and coping strategies of the poor. In 2000, leaders of 189 nations agreed on the Millennium Declaration that outlined eight fundamental goals. Climate change challenges the achievement of the Millennium Development Goals (MDGs) and related national poverty eradication and sustainable development objectives. Unless concrete and urgent steps are undertaken to reduce vulnerability and enhance adaptive capacity of poor people, and unless these actions are integrated in national strategies for poverty eradication and sustainable development, it may be difficult to meet some of MDGs by 2015. Strategies to strengthen capacity to cope with current climate variability and extremes and to adapt to expected future climatic conditions are mutually supportive and will have immediate benefits. They will also help identify and take advantage of the positive impacts of climate change. Even though both poverty driven systems and rural traditional economic systems appear to be generally more vulnerable to sudden disruptive changes than gradual ones, long-term climate change can be just as harmful, and would have severe impact on the resilience of even the most developed countries economies. Changes in average climatic conditions, as well as extremes, and loss of productive areas due to sea level rise, have both been highlighted in their projected impacts on the agricultural, energy and urban commerce. Changing El Nino ENSO behavioral patterns in the Southern Pacific Oceans are postulated to drastically affect the economies of Australia, Southeast Asia and many South American countries. Countries where tourism represents a major source of income may be affected by a decrease in revenues due to the effects of both gradual climatic changes and extreme weather events. Such events are likely to

alter the attractiveness of certain holiday destinations, for example coral reef mortality is expected to reduce income opportunities for local populations in some regions. All of these factors can affect the GDP of the particular country, balance of payments, level of indebtedness, state of public finances, and may divert investments from important development objectives.

Climate Insecurity, Vulnerability and Adaptability – Theoretical Framework

The last half decade has shown that our society and livelihood systems are becoming more exposed and vulnerable to the threat of climate extremes, variability and anomalies and our ability to adjust and adapt to these imposing conditions are becoming more demanding and would continue to do so in the near future. Vulnerability can be defined in many ways, and it is not the intention here to review them all. For a summary of definitions of and approaches to vulnerability and adaptive capacities the reader should consult Adger (1999) and Adger et al. (2004). Vulnerability of a community and system to a threat describes its susceptibility to be harmed by that threat. Social scientists and climate scientists have different interpretations of the term "vulnerability". Social scientists views vulnerability as representing the set of socio-cultural, economic, population and demographic factors that determine people's ability to cope with stress or change (Allen, 2003), whereas, climate scientists views vulnerability as the likelihood of impacts and stresses of weather and climate events or climate induced hazards on society and systems (Nicholls *et al*., 1999). Weather and climate induced hazards or events that describe changing behavioral trends of values or departures from the mean of values of variables such as rainfall, temperature, wind speed, water level, or a combination of parameters that could include factors such as speed of onset, duration, intensity, frequency, magnitude and spatial extent. A vulnerable system that is exposed and threatened by a hazard may be a region, population groups, community, ecosystem, country, economic sector, household, business or individual. Vulnerability in climate change studies falls into two categories, (1) the potential damage caused to a system by a particular climate induced hazard (Jones and Boer, 2003), for example what would be the impact of a 10 mm increase in sea level on the surrounding coastal ecosystems?, (2) the state of a system before it encounters a hazard event (Allen, 2003), for example the existence of early warning systems within a particular region which is been threatened by a low pressure systems. Climate change impacts studies have typically examined vulnerability of a human system as determined by the nature (behavioral patterns) of the physical events or hazard characteristics to which it is exposed, the likelihood or frequency of occurrence of the hazard(s), the extent of human exposure to hazard, and the system's sensitivity (inherent vulnerability and resilience of the system stress and changes) to the impacts of the hazard(s) threat. This view is apparent in the principal definition of vulnerability in the IPCC Third Assessment Report (TAR) and the Fourth Assessment Report (FAR (IPCC, 2001 and 2007) that describes vulnerability as "The degree to which a system is

susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of thee character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity". Adaptive capacity is "The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences". This combined vulnerability, a function of hazard, exposure and sensitivity, is sometimes referred to as *physical* or *biophysical vulnerability* (O'Brien et al., 2003). The term "biophysical" will be used here, as it suggests both a physical component associated with the nature of the hazard and its first-order physical impacts, and a biological or social component associated with the properties of the affected system that act to amplify or reduce the damage resulting from these first-order impacts. Biophysical vulnerability is concerned with the ultimate impacts of a hazard event, and is often viewed in terms of the amount of damage experienced by a system as a result of an encounter with a hazard. Conversely, the view of vulnerability as a state (i.e. as a variable describing the internal state of a system prior to the occurrence of a hazard event) has arisen from studies of the structural factors that make human societies and communities susceptible to damage from external hazards (Allen, 2003). In this formulation, vulnerability is something that exists within systems independently of external hazards. For many human systems (social and physical systems), vulnerability is viewed as an inherent property of that system arising from its internal characteristics. Inherent vulnerability is determined by factors such as poverty and inequality, marginalization, food entitlements, access to insurance and housing quality, presence or absence and the state of infrastructures and mitigation measures. In this formulation, it is the interaction of hazard with inherent vulnerability that produces an outcome, generally measured in terms of physical or economic damage or human mortality and morbidity (Brooks and Adger, 2003). The nature of a system's inherent vulnerability will depend on the nature of the hazard to which the system is exposed; certain properties of a system will make it more vulnerable to certain types of hazard than to others. For example, quality of housing will be an important determinant of a community's vulnerability to a flood or heat wave threat, but is less likely to influence its vulnerability to drought threat. In general human systems vulnerability can be differentiated based on their "generic" determinants and their "specific" determinants to particular hazards threats. The state of vulnerability for a particular system describes the risk of that system to harm by induced stresses. Low vulnerability – high resilience systems are associated with low risks to change and harm whereas high vulnerability – low resilience systems are associated with high risks to change and harm to induce stresses. Risk can be defined as a function of hazard and the inherent vulnerability of a particular system and is compatible with risk defined as probability x consequence, and also with risk defined in terms of outcome. The probability of an outcome will depend on the probability of occurrence of a hazard and on the inherent vulnerability of the exposed system, which will determine the consequence of the hazard. The

ambiguity as to whether it is the probability of occurrence of a hazard, or the probability of a particular outcome that is being referred to be addressed by Sarewitz *et al*. (2003). They define *event risk* as the "risk of occurrence of any particular hazard or extreme event" and *outcome risk* as "the risk of a particular outcome". They state that outcome risk "integrates both the characteristics of a system and the chance of the occurrence of an event that jointly results in losses." The principal difference between the natural hazards risk-based approach and the IPCC biophysical vulnerability approach is that risk is generally described in terms of probability, whereas the IPCC and the climate change community in general tend to describe (biophysical) vulnerability simply as a function of certain variables. Nonetheless, the determinants of both biophysical vulnerability and risk are essentially the same - hazard and vulnerability. The natural hazards community, which emphasizes risk, and the climate change community, which emphasizes vulnerability, is essentially examining the same processes. However, this has not always been immediately apparent, due to differences in terminology. Both are ultimately interested in the physical hazards that threaten human systems, and in the outcomes of such hazards as mediated by the properties of those systems, described variously in terms of vulnerability, sensitivity, resilience, coping ability and so on. The integration of the risk-based and vulnerability-based approaches is desirable if we are to address the numerous threats that human systems will face in the future as a result of climate variability and change, and also from non-climate hazards. As stated by Kasperson et al. (2001), "What is essential is to assess vulnerability as an integral part of the causal chain of risk and to appreciate that altering vulnerability is one effective risk management strategy."

Adaptive capacity and the adaptation process

The discussion above paved the way towards developing a conceptual framework of vulnerability and risk analysis of human systems under imposing stresses as a result of climate change. Many definitions of adaptive capacity exist (e.g. IPCC, 2001; Burton et al., 2002; Adger et al., 2003); broadly speaking it may be described as the ability or capacity of a system to modify or change its characteristics or behavior so as to cope better with existing or anticipated external stresses. We may view reductions in social vulnerability as arising from the realization of adaptive capacity as adaptation. The term adaptation is used here to mean *adjustments in a system's behavior and characteristics that enhance its ability to cope with external stresses*. Given constant levels of hazard over time, adaptation will allow a system to reduce the risk associated with these hazards by reducing its social vulnerability. Faced with increased hazard, a system may maintain current levels of risk. Through such adaptation; reductions in risk in the face of increased hazard will require a greater adaptation effort. If hazards increase dramatically in frequency or severity, a human system may face

greater risk despite reduction in social vulnerability achieved through the implementation of adaptation strategies. Societies have inherent capacities to adapt to climate change. These capacities are bound up in the ability of societies to act collectively. Decisions on adaptation are made by individuals, groups within society, organizations and governments on behalf of society. Although the capacity of individuals to adapt to climate change is a function of their access to resources, the adaptive capacity of societies and systems depends on the ability to act collectively in the face of the threats posed by climate variability and change. Thus adaptive capacity, as an element of overall vulnerability of a society, can be illuminated through examining the institutions for resource management and their effectiveness, efficiency and legitimacy. Social capital is made up of the networks and relationships between individuals and social groups that facilitate economic well-being and security. Indeed previous research in coastal environments demonstrates that social capital is and important element for coping with climate variability and hazard in the present day. The direct effect of adaptation is to reduce vulnerability. Whether or not this translates into a reduction in vulnerability or risk will depend on the evolution of hazard. In the case of anthropogenic greenhouse warming and any associated changes in climate, the only certain way of reducing risk is therefore via a combination of adaptation and mitigation strategies, the purpose of the latter being to reduce hazards. Adaptation does not occur instantaneously; a system requires time for its adaptive capacity to be successful as adaptation. Adaptive capacity represents *potential* rather than actual adaptation. A high level of adaptive capacity therefore only reduces a system's vulnerability to hazards occurring in the future (allowing the system time to adapt in an anticipatory manner) or to hazards that involve slow change over relatively long periods, to which the system can adapt reactively. The damage to a system resulting from a discrete hazard event such as a storm or flood occurring tomorrow would not be a function of the system's ability to pursue future adaptation strategies – it is existing adaptations resulting from the past realization of adaptive capacity that determine current levels of vulnerability. The likelihood of a system adapting responsively to (as opposed to coping with) a sudden short-lived event such as a hurricane is negligible. However, a system's vulnerability to more gradual, longer-term change will be a function of its ability to adapt incrementally and responsively, and its vulnerability to discrete hazards occurring in the future will be a function of its ability to anticipate and pre-empt those hazards via appropriate planned adaptation strategies. The rate at which *risk* (or biophysical vulnerability) associated with a particular type of hazard is reduced (or increased) will depend on the timescales associated with the implementation of adaptation measures (i.e. the realization of adaptive capacity as adaptation) and also on the timescales associated with the evolution or occurrence of the hazard in question (in the case of global-scale anthropogenic climate change the latter will be influenced by global development pathways and the extent to which mitigation is pursued). In other words, we must ask ourselves whether a system is likely to implement the necessary adaptation measures in the time available to it in order to reduce risk to a subjectively defined acceptable

level. For example, global mean sea level is expected to rise by a maximum of around 45 cm by 2050 (Sear et al., 2001). While many countries are *currently* vulnerable to a 45 cm sea level rise (assuming no further adaptation were to occur over the next half-century), for this particular threat we are concerned with future vulnerability, perhaps assessed in terms of the ability to cope with a given annual or decadal rise in sea levels up until the middle of the twenty first century. The risk posed to a country or coastal zone by sea level rise will depend on the rate at which it occurs, the system or region's existing vulnerability, and the rate at which the system can adapt. Existing vulnerability is important as it constitutes the "baseline" from which any reduction of vulnerability to "acceptable" levels via adaptation must take place. Another way of addressing the important issue of timescale is to distinguish between current and future vulnerability. Current vulnerability, determined by past adaptation and the current availability of coping options, provides a baseline from which a system's future vulnerability will evolve. This evolution will be mediated by the system's adaptive capacity and the extent to which this capacity is realized as adaptation. At any given time, we may view a system as exhibiting a certain degree of vulnerability to a specified hazard, and as having a certain capacity or potential to adapt so as to reduce its Vulnerability to that hazard within any given time frame constrained or modulated by a range of external factors. If the hazard in question is a particular type of discrete, transient, extreme climatic event, we may speak in terms of the system's *current vulnerability*, a "snapshot" which determines the extent to which it would be damaged if the event in question occurred immediately. We may also speak of the system's *potential vulnerability*, or the vulnerability it would have at a specified point in the future to a specific hazard as a result of realizing all its current adaptive capacity through anticipatory adaptation. If we assume that adaptation is a function of adaptive capacity only, in other words that all a system's adaptive capacity is realized as adaptation, a system's *actual vulnerability w*ill vary with time as its adaptive capacity fluctuates in response to changes in environmental, political, social and economic. Adaptive capacity may also be reduced by the impacts of the very hazards that a system must adapt to. The above allows vulnerability and adaptation studies to be put on a more quantitative footing where this is deemed to be desirable, for example in terms of integrated assessments involving modeling components, or where quantification is useful in order to assess the success or failure of adaptation strategies. Differences in social vulnerability resulting from different development pathways might be assessed by running models with a suite of different socio-economic scenarios under conditions of constant hazard. Outcomes measured in terms of mortality and morbidity or economic damage could then be used to assess the impacts of different modes of development on social vulnerability (assuming each socio-economic scenario is associated with the same hazard(s)). Of course vulnerability is also influenced by hazard events through a variety of feedback processes such as the destruction of resources and the exacerbation of poverty and inequality by climate-related disasters.

Potential Drivers of Climate Change in Malaysia

The cause – effect linkages between green house gases emission and global warming would be the prime driver of climate change. However, global warming and its effects on climate change vary within a space – time continuum. What this means is that from now and the immediate future certain regions would be much hotter and certain regions much colder than other parts of the world. Temperature gradient changes between hot and cold regions over the earth's surface would greatly influence the behavioral patterns of the Earth's atmosphere, oceanic and land based circulation systems, which in most cases are detrimental in influencing local and regional climates. The climate of Malaysia and the Southeast Asia region are greatly dictated by the behavioral patterns of the Monsoons (Northeast and Southwest), the el Nino ENSO event of the South Pacific Ocean and to a certain extent the Indian Dipole Oscillation of the Indian Ocean, and to a certain extent local river basin circulation systems. Changes to the behavioral patterns of these major circulation systems would bring about an increase in the time of onset, timing of occurrence, intensity, frequency, magnitude, and duration of impact of floods, droughts, coastal inundation and erosion, ground water contamination, ecological displacements and manifestations, emergence of diseases in new regions (such as highlands), accelerated erosion, rapid slope failures and associated debris flow and other forms of climate induced hazards. The Third and Fourth Assessment Report (TAR and FAR) of the Intergovernmental Panel on Climate Change (IPCC, 2001; 2007) states that -"climate change will lead to an intensification of the global hydrological cycle and can have major impacts on regional water resources, affecting both ground and surface water supply for domestic and industrial uses, irrigation, hydropower generation, navigation, in-stream ecosystems and water-based recreation. Changes in the total amount of precipitation and in its frequency and intensity directly affect the magnitude and timing of runoff and the intensity of floods and droughts; however, at present, specific regional effects are uncertain. The impacts of climate change will depend on the baseline condition of the water supply system and the ability of water resource managers to respond not only to climate change but also to population growth and changes in demands, technology, and economic, social and legislative conditions. In some cases - particularly in wealthier countries with integrated water-management systems - improved management may protect water users from climate change at minimal cost; in many others, however, there could be substantial economic, social and environmental costs, particularly in regions that already are water-limited and where there is considerable competition among users." The tragedy of 'the poor and low income groups' is linked strongly to the access to water. The poor generally live in a critical balance with the water resources available. For that reason, the people who are most vulnerable to current climate change - variability effects are the poor, more so for developing regions like Southeast Asia. In the context of long-term climate change and possibly enhanced climate variability, it is once again the poor who will suffer most. Whereas in the rich regions of the world, people have a relatively large coping capability, in developing countries a small change in climate variability (i.e. slightly higher frequency of extreme events or a slightly shorter growing period) can have very large effects in terms of food and

water security, health, mortality and economic well-being. By affecting climate, and hence climate variability, the rich may affect themselves, but more and in particular the poor. The political issue that thus emerges is which mechanism one can put in place to 'institutionalize' the responsibility of the rich (North) towards the poor (South). On the one hand, this responsibility can be translated into international agreements on the reduction of greenhouse gas emissions. That has to take place particularly in the North. On the other hand, the North should take the responsibility to contribute to demand-driven institutional capacity building in the South, albeit in a non-political threat way, in order to help increase the capacity in the South to cope with impacts of climate variability and climate change.

Potential Implications of Climate Change on Malaysia – the Case of Low Income Populations

Malaysia has an enviable record in terms of achieving success in poverty reduction. The incidence of poverty for 1976 to 2004 shows a phenomenal reduction in the incidence of poverty from a very high 49.3% in 1970 to a commendable low of 5.7% in 2004 (Economic Planning Unit 2007). This is an achievement that is largely attributable to the growth in household income over the same period coupled with a reduction in inequality in the distribution of income. Despite the spectacular reduction of poverty in Malaysia, an estimated 2.7% of the population is still below the poverty line in the year 2007. Not withstanding the strides made in poverty reduction there are still significant disparities between urban and rural households and between urban and rural economies. Economic growth and widespread government interventions are the key ingredients to Malaysia's success on poverty reduction. It is also critical that the targets of poverty abatement programmes were sharply defined as in the case of the hardcore poor. Malaysia has been on a high and rapid growth scenario, averaging 9% between 1990 and 1997 prior to the Asian financial crisis. During the same period, poverty incidence has been continuously declining from 16.5% in 1990 to 6.1% in 1997 before the crisis. While the crisis reversed previous trends, such that poverty incidence rose by 1.5 percentage points to 7.5% in 1999 from 6.1% in 1997, the rate is still low as compared to that of other countries. It is widely acknowledged that poverty is multi-dimensional and as such study of poverty in any country must be based on a range of measures and indicators. These may include the level of expenditure on food and the availability and distribution of nourishment; access to basic amenities such as housing, clean water and sanitation; ability of households to access heath and education. In general recognition of the complexity of studying the nature and extent of poverty the Millennium Development Goals set targets to achieve a level of poverty alleviation based on a range of measures. Notwithstanding the complexity and multidimensional nature of poverty, total and per capita household expenditure remains a very important determinant of poverty. Household expenditure and income dictate a household's purchasing power and its ability to meet its basic needs and beyond. Furthermore, it is common place to observe a strong correlation between the level of household expenditure and other poverty-determining characteristics. Considering measurement issues, it is also acknowledged that

household expenditure is a more reliable yardstick to determine the poverty status of the household than the household income. Household expenditure coupled with government expenditure on behalf of households on important services like housing, education, health and basic social and economic infrastructure are the key factors affecting the incidence and severity of poverty in any given country (D.S. Prasada Rao, 2006). The first and the most important step in the study of poverty is the determination of the poverty line. Poverty lines are used in estimating the incidence of poverty as well as in examining the nature and severity of poverty in any given country. Poverty lines may be determined in different countries using the absolute or relative concepts. In most developing countries the absolute concept of poverty line or some variant of it is used. Even within a country, several poverty lines are usually in existence. These poverty lines refer to different geographical regions, for example rural and urban, or for different time periods or for households of different sizes and composition. In Malaysia the poverty line is set at ~RM500.00 (as compared to ~ US10,488 in the United States of America for a single person under 65 years), whereas a value of about ~RM1750.00 (?) has been considered to be more representative for urban areas. Though there are major debates on what value should constitute the poverty line the expectation is that this threshold value should be able to provide for a comfortable and decent living of the household members without any breakdown on the whole rubric of social structures of that household unit. This threshold value also describes the level of vulnerability (to use the metaphor "money got money buys") inherent in the household unit and its ability to adapt to imposing conditions detrimental to its survival that could undermine its stability and continued sustenance. Poverty reduction programmes could thus be summarized as consisting of two main objectives - to reduce vulnerability and increase the adaptive capacities of the individual household unit to achieve and sustain some level of quality of life standards. Computation of the poverty line value must take into account of the climate change threat as the costs of adapting to sustain household comfort, health and livelihood economic activities would be costly and increasing as global warming increases. Though the incidence of poverty in Malaysia is very low (~2.7%) in 2007 the poverty line value of RM500.00 would not be sufficient to offset the climate change threat. Even for developed countries such as the European Union and the United States whose poverty line index is much higher than Malaysia, the adaptive capacities of the population to adapt to the climate change threat is very much limited as evident by the number of deaths attributed to heat waves and cold snaps. Hurricane Katrina which hits the Gulf Coast of the United States for the period 23-29 August 2005 brought about death and destruction costing billions of dollars, population displacements, and poverty and changing social structures. What this means is that there is a substantial percentage of the country's population whose household income might be higher than the poverty line value but would be still be exposed to the climate change threat – they are vulnerable and their adaptive capacities limited. Cyclone Nargis which hits parts of Myanmar recently affected rural populations which was already well below the country's poverty threshold. Another factor that needs to be considered is the *cause – effect linkages* between climate change, environmental resources development and poverty. The metaphor "the poorer gets poorer and the richer gets poorer" could be used to explain when economic systems that are very dependent on climate as a resource fails as a result of climate change.

Traditional economic systems which are environment driven such as that found in Malaysia's highland regions, coastal – island regions and urban regions where economic activities are often been directly or indirectly dictated by the behavioral patterns of climate and weather are the most susceptible to changes in the cause – effect linkages between climate change, environmental resources development and the incidence of poverty (Plates). According to the IPCC (2007) the total temperature increase from 1850-1899 to 2001-2005 is 0.76^{o} C (0.57^{o}C to 0.95^{o}C), this amount of increase spanning ~ 150 years have set in motions changing behavioral patterns within the atmospheric, oceanic and land based (drainage basins) circulation systems. Eleven of the last twelve years (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850) and are thought to influence the increasing intensity, frequency, magnitude of impacts, duration, time of onset and timing of occurrence of low pressure system cells across the Pacific and Atlantic Oceans (WMO, 2007, Figure). What is important here is that the postulated gradient of temperature trend increases from 2007 to 2100 would be much more steeper (although based on different scenarios projection models of fossil fuel utilization) and the implications on the Earth's atmospheric, oceanic and land based systems (river basins) circulation behavioral patterns should change drastically and certain threshold boundaries within the systems breached and the impact on poverty and human security issues would be cataclysmic. Malaysia's being an archipelago; her coastline would experience severe erosion, saltwater intrusion, groundwater contamination, destruction of extensive mangrove forests and habitat displacements and migrations. Malaysia's coastal populations and their activities (traditional and modern) would be seriously affected and what Bangladesh faces in terms of her flood threats and disasters in the last half decade or so could be seen for Malaysia's coastal regions.

Potential Impact of Climate Change on the Poor (Poverty Driven)

Climate change creates shocks and stresses and is already known to have a devastating impact on the vulnerability of the poor as evident in the food crisis, water crisis, and impact of diseases outbreaks in the African continent, the Indian subcontinent and certain parts of Southeast Asia in the last half decade or so. Increasing frequency and intensity of weather-related extremes and anomalies, and the gradual changes in the average regional temperatures and changing patterns of regional rainfall will exacerbate these impacts (to a certain threshold by which after this there could be a cataclysmic collapse of the whole rubric of human social and economic systems). This would have serious implications on the existing vulnerability of the poor to offer any form of resilience and adaptation to the threat. Even within a livelihood adapted to a particular climatic stress, an increase in intensity of the stress, climate extremes, or unseasonal changes can cause severe shocks that set back households. Coping with such events can result in a loss of assets, negative impacts on health and can require high expenditure in order to recover. In a set of participatory poverty assessments from over 24 countries, the rural and urban poor identified natural hazards, changing climate conditions and

unpredictable seasons as contributing to an increasingly fragile environment and increasing the vulnerability of their livelihoods (Department of International Development 2004a, 2004b). During the 1998 floods in Bangladesh, some households were able to use emergency food and change their employment away from agriculture in order to cope. However, poorer households coped through reducing food consumption and through the sale of assets, reducing their resilience to future shocks. The poor are often the most exposed to climate variability because of where they live or their livelihood activities. The urban landless are particularly vulnerable to climate extremes, as illustrated in Honduras, where hillside shantytowns were amongst the worst affected by intense rainfall and landslides during Hurricane Mitch. Pastoralists are often particularly vulnerable to drought due to their dependence on marginal lands. Within poor communities, women and children may be particularly exposed, as seen in Bangladesh where they made up 90% of the victims during the 1991 cyclone. This incidence rate was related to a range of factors including their capabilities in survival (e.g. swimming), and socio-cultural beliefs that prevented women with their children from congregating in public cyclone shelters. As a result of social or political restrictions, the poor may also be forced to remain in exposed areas after a shock or stress. Following the torrential rains of 1999 in Venezuela, a large number of the marginalised poor were forced to rebuild their homes in the same risk-prone ravines due to a lack of alternatives. The Millennium Development Goals (MDGs) recognize the role of poor health in increasing the vulnerability of individuals of certain age groups, gender and social status, and of perpetuating vulnerability by hindering education and livelihoods. Climate change will modify the dispersal, reproduction, maturation and survival rate of vector species. Climate change will worsen health principally through: increased vulnerability to poor health due to reduced food security and water security; water-borne diseases associated with reduced water quality due to floods and drought; more favorable conditions for the spread of vector-borne and air-borne diseases; and the direct link between temperatures and heat stress1.Food insecurity and water insecurity are likely to increase because of the greater frequencies of droughts and floods, which have a direct impact on areas vulnerable to malnutrition. Climate change will also have an impact on food supply in the wider economy (due to impacts on large scale agriculture, loss of land through rising sea level and salinisation, and the impacts of rising sea level and changes in water temperatures, currents, freshwater flows and nutrient circulation on fisheries production).Malnutrition is a global health problem and it is estimated that approximately 790 million people do not have adequate nutrition. Regions where malnutrition is widespread are usually areas characterised by erratic rainfall, resulting in highly variable agricultural yields seasonally and from year to year. This yield variability can lead to malnutrition or even famine where it is combined with the absence of effective coping strategies or safety nets. Groups that are most at risk from malnutrition include the rural producers, pastoralists, rural labourers, the urban poor people, refugees and displaced people. Pastoralists in particular will be affected by lowered livestock productivity and death due to drought, floods or disease. Currently approximately 1 billion people do not have access to safe water, and suffer from water-borne diseases. Climate change will increase the occurrence of conditions that favour the spread of water-borne disease. Increases in temperature and humidity result directly in increased rates of

reproduction and survival of bacterial, protozoan and viral pathogens. Many diarrhoeal diseases, which can be transmitted via multiple routes, peak in the hottest months of the year, e.g. Salmonella and Shigella. In situations of drought, the reduced water supply results in an increased rate of waterborne disease due to both physical and human factors: there is an increased concentration of pathogens in water sources as pathogens multiply at an increased rate, and the volume of water decreases; people are forced to use more contaminated sources as their preferred source runs out; and there will be increased concentrations of people around the remaining water points. Floods can result in acute health impacts for vulnerable regions, through increases in infectious diseases increases in respiratory and diarrhoeal diseases because of crowding of survivors, often with limited shelter and access to potable water. Floods can also disrupt water supply or sewerage systems, and lead to exposure to dangerous chemicals or pathogens released from storage sites and waste disposal sites. Sudden onset of floods can also cause injury, and the impact on livelihoods causes increased anxiety and depression. Vector-borne infectious diseases, such as malaria and dengue fever, have a significant impact on health and poverty. Currently, approximately 40% of the world's population is at risk from malaria, and this is projected to increase to 80% by 2080. More than half the world's population live in areas at risk of dengue fever. Climate change will modify the dispersal, reproduction, maturation and survival rate of vector species and consequently alter disease transmission. Temperature, humidity, rainfall, soil moisture and the rising sea level are changes in climate that have implications for disease transmission. The following vector borne diseases are considered sensitive to climate change, (1) Malaria – transmitted by mosquitoes in tropical areas, (2) Dengue – transmitted by mosquitoes, (3) Schistosomiasis – transmitted by flat worm; and (4) Tick-borne diseases. Climate change will increase the occurrence of conditions that favour the spread of waterborne disease. Climate already plays a significant role in health. Our current climate has a number of implications for health of the poor and their livestock. Current climate affects health outcomes through: 'Climate envelopes' i.e. areas of a particular climate and ecosystem; Seasonality; Inter-annual variability; Climate extremes (shocks); and Climate shifts (decadal). Climate envelopes - Certain diseases are confined to areas of a particular climate and ecosystem i.e. 'a climate envelope'. Malaria is a case in point where, depending of the type of mosquito-vector, the distribution is limited by certain climatic and environmental conditions, in particular temperature and humidity. Seasonality- A number of infectious diseases (e.g. vector borne and bacterial diseases) is closely associated with seasonal patterns. For example in the Gambia, diarrhoea in young children has been linked with the summer rains. In West Africa, meningitis is associated with dust in semi-arid conditions, and among people with poor, overcrowded living conditions. Inter-annual variability- Variability in water supplies or food security can be a consequence of inter-annual climate variability where poor planning systems are combined with reduced rainfall or reduced river flows. In 2000, 18,000 villages in Gujarat were faced with serious water shortages following the worst drought in 100 years. Climate extremes- Extreme climatic events can trigger infectious diseases or death, disrupting access to health services, and causing the displacement of people. a) Infectious diseases and death - Infectious diseases and death are often associated with climate extremes. The poor are most often the victims of such impacts owing to their inability to protect themselves.

Following the flooding associated with Hurricane Mitch (1999), the incidence of cholera increased four-fold in Guatemala and six-fold in Nicaragua. In May 2002 an intense heat wave hit southern India killing more than 1,000 people, mainly those living in over-crowded conditions or out-doors labourers. Bangladesh has experienced an increase in cholera occurrence with the increase in the severity of El Niño-related floods over the past 70 years. Rift Valley Fever among livestock is associated with heavy rainfall: for example, flooding associated with the 1997-8 El Niño led to the loss of huge numbers of livestock to Rift Valley Disease and resulted in a billion dollar ban by the Gulf States on trade from East Africa. b) Disrupting access to health services- Climate extremes such as flooding or windstorms can disrupt access to health services through damage to facilities and transport networks. The 1997-1998 El Niño flooding and hurricane events across Ecuador and Peru resulted in damage to 34 hospitals and 485 health centres, many of which were the only facilities for miles around. The 1999 floods in Mozambique caused damage to road networks estimated at US$6 million. Despite the essential role of health services following such a disaster there is often no means in place to protect medical supplies or quickly reinstate access to health services. c) Displacement- Extreme events are also associated with the displacement of people, makeshift accommodation, inadequate facilities, and inadequate nutrition. Incidences of TB and malaria have been found to increase in refugee camps as a result of the overcrowded conditions and lack of protective elements of the home. Climate shifts - Climate shifts over decades can result in landuse change and migration. Land-use influences the environmental conditions that limit certain diseases, and migration can have implications for the spread of diseases (e.g. HIV/AIDS). In Malaysia, though the level of poverty incidence had dramatically lowered to a very low of ~2.7 % in 2007, two important issues needs to be ascertained. Firstly, at that level of the poverty line value of ~RM500, can the poor cope to the impending threat, and secondly, which is considered more important is that if this value is insufficient than the existing poor (and hardcore poor) becomes more vulnerable but the percentage of the population becoming vulnerable to the climate change threat would also increase till a new poverty line value that incorporates the climate change threat be included in calculating the new poverty line value. To these two issues a third can be added where existing poverty abatement programmes which had never incorporate the climate change threat would have failed and the incidence of poverty would increase in the following years. The United Nations Millennium Development Goals would be severely handicapped and the possibility of not achieving its target in 2015 as a result of climate change threat. Climate change adds urgency to understanding and addressing the poor's vulnerability to current and future climate variability and to reevaluating the role of policies and programmes in reducing this vulnerability. Vulnerability is an indication of people's exposure to external risks, shocks and stresses and their ability to cope with, and recover from, the resulting impacts. Vulnerability may differ seasonally or at different times within people's lives. It also differs across groups within communities or individuals within a household, owing to their livelihood activities or social standing. People draw on a range of coping strategies in times of stress; however, those available to the very poor are likely to be more restricted and less resilient. Changing vulnerabilities can often explain how people move in and out of poverty, suddenly, seasonally or gradually overtime.

People may use a number of strategies to move out of poverty, but without also reducing their vulnerability they can easily slip back into poverty at a later date. Malaysia's effort to address the poverty issue is commendable, however, the climate change threat also shows that poverty line calculations must incorporate adaptive costs to climate change threat and with escalating food and energy costs, the government must reassessed the poverty line index as the bulk of the population belongs to the low income groups though lying just above the poverty line but would be seriously affected by these imposing changing conditions.

Adapting to Climate Change – What Needs to Done?

People and systems develop coping strategies to deal with climate variability and extremes as with other shocks or stresses. These include building social networks as forms of insurance, traditional forecasting in order to be prepared for climatic changes and ingenious means of protecting assets such as the use, in Asia, of floating seed beds in times of floods. However, the poor's range of coping strategies is naturally more restricted by their lack of assets and by the other stresses on their livelihoods. The poor are already struggling to cope with current climate variability and extremes. The climate is becoming more variable and creating additional risks so that the poor are becoming more vulnerable. As climate extremes are 'covariant risks' (i.e. simultaneously affecting a wide range of people), current safety nets are likely to be overwhelmed. This includes both formal systems (e.g. social assistance), and informal systems (e.g. social networks).Many developing countries are already taking action to adapt to climate change, beginning with an analysis of their vulnerability. Vulnerability to climate variability has significant implications for the achievement of the Millennium Development Goals. Development must be based on understanding existing and future vulnerabilities to climate risk if it is to be resilient to the risks of climate change. In some cases climate change adds urgency to current activities to improve policies and institutional mechanisms that impact on the poor. In other instances there may be a case for changes in planning or institutional reform to take account of climate risks, or for building additional capacity into infrastructure investment. Whatever the response, it should be an integral part of development planning. This involves three main steps; (1) understanding the behavioural patterns of climate induced stresses, (2) understanding the vulnerabilities and inherent adaptive capacities of human systems, and (3) understanding the impacts of climate induced stresses and how to build up resilience of affected human systems. Vulnerability analysis can be strengthened by understanding climate hazards better. Based on an understanding of vulnerability, governments can reduced the burden of climate risks and taking specific actions to reduce the vulnerability of the human systems by integrating climate risks into development planning programs. Responding to climate variability requires development agencies and governments to work on the development of strategic planning systems, which take account of current and projected climate patterns. Compared with industrialised countries, most developing nations have small greenhouse gas emissions, making mitigation a less urgent priority. Adaptation is very important in poor countries because they are more

vulnerable to the impacts of climate change. Broadly speaking, there are two reasons for this vulnerability. One is low adaptive capacity — high levels of poverty and a relative lack of the financial capability, institutional strength, skills, infrastructure, technology and other elements needed to cope with the effects of climatic shifts. The other is geographic location: large numbers of poor people live in areas such as drought-prone sub-Saharan Africa or flood-prone Bangladesh. Reliance on climate-sensitive sectors such as agriculture and fishing is also high in developing countries. The IPCC recognises Africa as a whole to be "one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capacity". In Asia, "coastal areas, especially heavily-populated mega-delta regions in South, East and Southeast Asia, will be at greatest risk due to increased flooding from the sea and, in some mega-deltas, flooding from the rivers". The IPCC also states that "small islands, whether located in the tropics or higher latitudes, have characteristics which make them especially vulnerable to the effects of climate change, sea level rise and extreme events. There are two types of responses to the threat of climate change. The first, mitigation, involves reducing emissions of greenhouse gases as a way of slowing or stopping climate change. The second, adaptation, is learning to cope with temperature increases, floods and the higher sea level associated with climate change. Adaptive responses can be technological (such as sea defence construction), behavioural (such as altered food and recreational choices), managerial (such as altered farm Adaptation to climate change needs to be mainstreamed into development policy and practice at national, international and regional levels. Particular attention needs to be paid to supporting community-based approaches to adaptation. Building on the considerable body of knowledge already possessed by poor people is essential. In the Yamuna River area of Rajasthan, India, for instance, a number of poor communities have revived traditional rainwater harvesting methods in the form of johads — small semicircular dams— and helped recharge groundwater and virtually drought-proof their villages. At the country - level response, climatic change is just one aspect of the external events and changes to which economies and societies must adapt. Governments can, however, attempt to increase the resilience of their growth strategies to the impacts of increasing climate variability and climate change. Unfortunately there is, as yet, little experience of best practice of adaptation to climate change on which to draw, but experience of more general adaptive economic policies offers some pointers. Maintain the principles of good economic policy that assist adjustment to exogenous factors such as climate shocks. Governments can best do this by, maintaining a policy environment conducive to changing market trends? Governments should allow prices to reflect the changing availability of resources and avoid economic instruments – such as guaranteed prices or quotas – which may distort rational decision making at a time when change is needed; Avoiding mechanistic responses that impose direct or indirect subsidies to protect the status quo, and result in increasingly large and unsustainable fiscal burdens; Including contingencies for climatic variability within budget planning processes; Encouraging individuals to move away from geographical areas or sectors most affected by climate change; and removing restrictions that confine the poor to increasingly unsustainable livelihoods or marginal areas. Support technological development and the provision of information in sectors that will allow individuals and markets to adapt to, or mitigate the impact of climate change. These could

include new varieties of crops or adoption of more water-conserving technologies by industry. Governments have a role in disseminating information on forecast climatic events, and forecast impacts on natural resources, water resources and disease. Support governments to assert the risks of climate change and their economic implications in their agreements with international financial institutions (IFIs). Equally, IFIs and development agencies that engage in policy dialogue with governments should accept the requirement to mainstream climate change into macroeconomic policies and targets, in order to develop sustainable pro-poor growth. Many developing countries have a good core of professional planners and managers operating in key sectors. But they are usually unaware of the potential impacts of climate change on their sector. Climate risk assessment — studies to determine how robust infrastructure, services and other elements of development will be in the face of climate change — needs to be incorporated into development activities by all these professionals. For example, professionals involved in planning and managing for irrigation, flood management and drinking water provision need to factor climate change risk management into their regular practices for designing water structures and measures. Vulnerability to climate change can be reduced or increased by the choice of development path. For example, national investment in large-scale agricultural programmes may be misplaced if more droughts and flash floods are expected. Small-scale drought resistant agriculture might be more sustainable in the long term. Each country needs its own plans and institutions to ensure adaptation is both mainstreamed into development activities (such as integrated water resources management) and considered at a strategic planning level (for example, planning for increased malaria incidence in the health sector). The LDCs are currently preparing National Adaptation Plans of Action (NAPAs), which alongside other national strategies and plans should help link knowledge on climate change impacts and adaptation into national policy and planning processes. Incorporating climate change risks into national development activities at both project and strategic levels requires greater institutional capacity in most developing countries.

Conclusions

The potential threat of climate change induced hazards exacerbating risks in Malaysia should not be taken lightly. Although the IPCC 2007 report on the "Science of Climate Change" shows a small increase in temperature for the Southeast Asia Region in the last 50 years or so, there is general agreement amongst scientists that the changing behavioral patterns of the el-Nino ENSO , Monsoons and to a certain extent the Indian Dipole Oscillation circulation systems are triggering weather extremes and variability to influence changing behaviour patterns of hydro-meteorological and geomorphological events (floods, haze pollution and slope failures) in the region. To this date the impact of these changes can still be absorbed by the strong foundations of Malaysia's environmental management programmes and backed by her stringent economic policies including effective poverty eradication programs. However, this scenario can change if the gradual increase in global warming is left unchecked and unabated because increasing global temperatures

could lead to thresholds been breached where habitats and ecosystems could not recover to existing equilibrium and stable conditions. Malaysia's must strengthened her environmental management programmes and their implementations taking into account the climate change threat. In relation to this Malaysia needs to address the issues of vulnerability and adaptive capacities of her economics systems more so that which are been practiced by the poor or those within boundaries of the poverty line. The poor are especially vulnerable and their inherent adaptive capacities and coping mechanisms low. Malaysia needs to reassess the significance of the existing poverty line value to take into account the challenge of climate change threat and gives the poor and those living within the fringes of the poverty line to be able to reduce their vulnerability to the threat. This however needs to be done within the context of streamlining existing environmental management strategies within the context of existing National Economic Development programmes.

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